W91321-04-C-0023

LOGANEnergy Corp.

Los Angeles AFB PEM Demonstration Project
Final Report

Proton Exchange Membrane (PEM) Fuel Cell Demonstration
Of Domestically Produced PEM Fuel Cells in Military Facilities

US Army Corps of Engineers
Engineer Research and Development Center
Construction Engineering Research Laboratory
Broad Agency Announcement CERL-BAA-FY03

Ft MacArthur Civil Engineering Office, LA Air Force Base, CA

March 20, 2007

Executive Summary

Under terms of its FY'03 DOD PEM Demonstration Contract with ERDC/CERL, LOGANEnergy installed a Plug Power GenSys 5kWe Combined Heat and Power fuel cell power plant at Los Angeles AFB. The unit was installed at Ft. MacArthur Civil Engineering Headquarters, Building 56. The period of performance was extended to cover 17 months instead of the normal 12 due to additional funding transferred from another site. While operating on natural gas in a CHP configuration, the project achieved 87% availability over the 17 month period. However, this site achieved an overall availability of 97% for the best 12 out of 17 months.

The unit was electrically configured to provide grid parallel/grid independent service to the facility, and was thermally integrated with the facility's gas-fired water heater to support domestic thermal loads. Electric power service and natural gas service was provided by Southern California Edison. Based on final calculations incorporated in this report, fuel cell operations cost LA AFB an additional $278 energy expense over the performance period.

The LA AFB POC for this project was Eddie Wilson whose coordinates are:
Telephone: 310-363-0904
Email: eddie.wilson@losangeles.af.mil

Table of Contents

Update Table of Contents

Proposal – Proton Exchange Membrane (PEM) Fuel Cell Demonstration of Domestically Produced Residential PEM Fuel Cells in Military Facilities

1.0 Descriptive Title

LOGANEnergy Corp. Residential PEM Fuel Cell Demonstration at Los Angeles AFB, CA.

2.0 Name, Address and Related Company Information

LOGANEnergy Corporation

1080 Holcomb Bridge Road
BLDG 100- 175
Roswell, GA 30076
(770) 650-6388

DUNS 01-562-6211
CAGE Code 09QC3
TIN 58-2292769

LOGANEnergy Corporation is a private Fuel Cell Energy Services company founded in 1994. LOGAN specializes in planning, developing, and maintaining fuel cell projects. In addition, the company works closely with manufacturers to implement their product commercialization strategies. Over the past decade, LOGAN has analyzed hundreds of fuel cell applications. The company has acquired technical skills and expertise by designing, installing and operating over 100 commercial and small-scale fuel cell projects totaling over 9 megawatts of power. These services have been provided to the Department of Defense, fuel cell manufacturers, utilities, and other commercial customers.

3.0 Production Capability of the Manufacturer

Plug Power manufactures a line of PEM fuel cell products at its production facility in Latham, NY. The facility produces three lines of PEM products including the 5kW GenSys5C natural gas unit, the GenSys5P LP Gas unit, and the GenCore 5kW standby power system. The current facility has the capability of manufacturing 10,000 units annually. Plug will support this project by providing remote monitoring, telephonic field support, overnight parts supply, and customer support. These services are intended to enhance the reliability and performance of the unit and achieve the highest possible customer satisfaction. Vinny Cassala is the Plug Power point of contact for this project. His phone number is 518.782.7700 ex1228, and his email address is vincent_cassala@plugpower.com.

4.0 Principal Investigator(s)

Name	Chris Davis	Keith Spitznagel
Title	COO	Vice President Market Engagement
Company	LOGANEnergy Corp.	LOGANEnergy Corp.
Phone	770.650.6388 x 102	860.210.8050
Fax	770.650.7317	770.650.7317
Email	cdavis@loganenergy.com	kspitznagel@loganenergy.com

5.0 Authorized Negotiator(s)

Name	Chris Davis	Keith Spitznagel
Title	COO	Vice President Market Engagement
Company	LOGANEnergy Corp.	LOGANEnergy Corp.
Phone	770.650.6388 x 102	860.210.8050
Fax	770.650.7317	770.650.7317
Email	cdavis@loganenergy.com	kspitznagel@loganenergy.com

6.0 Past Relevant Performance Information

a) Contract: PC25 Fuel Cell Service and Maintenance Contract #X1237022

Merck & Company
Ms. Stephanie Chapman
Merck & Company
Bldg 53 Northside
Linden Ave. Gate
Linden, NJ 07036
(732) 594-1686

Contract: Four-year PC25 PM Services Maintenance Agreement.
In November 2002 Merck & Company issued a four-year contract to LOGAN to provide fuel cell service, maintenance, and operational support for one PC25C fuel cell installed at their Rahway, NJ plant. During the contract period the power plant has operated at 94% availability.

b) Contract: Plug Power Service and Maintenance Agreement to support one 5kWe GenSys 5C and one 5kWe GenSys 5P PEM power plant at NAS Patuxant River, MD.

Plug Power
Mr. Vincent Cassala
968 Albany Shaker Rd.
Latham, NY 12110
(518) 782-7700 ext 1228

LOGAN performed the start-up of both units, after Southern Maryland Electric Cooperative completed most of the installation work, and continued to provide service and maintenance during the period of performance.

c) Contract: A Partners LLC Commercial Fuel Cell Project Design, Installation and 5-year service and maintenance agreement.
Contract # A Partners LLC, 12/31/01

Mr. Ron Allison
A Partners LLC
1171 Fulton Mall
Fresno, CA 93721
(559) 233-3262

On April 20, 2004 LOGAN completed the installation of three 600kWe PC25C CHP fuel cells in Fresno, CA. The fuel cells also provided low-grade waste heat at 140 degrees F that furnished thermal energy to 98 water source heat pumps located throughout the 12-story building during the winter months.

7.0 Host Facility Information

Los Angeles AFB

Fort MacArthur Base Housing

Los Angeles Air Force Base is located within the El Segundo city limits, the base is divided into two areas; Area A where most major units are located, and Area B which houses the 61 Air Base Group, the clinic, BX, and the commissary.

Space and Missile Systems Center (SMC) traces its origins to the Western Development Division created in July 1954. The organization's original mission was to develop ICBMs and the results are a proud legacy with the early Atlas, Thor, and Titan of the 50s, through the Minuteman of the 60s, to the Peacekeeper of the 80s. SMC has been the center of military satellite development since 1956. The Center has contributed to maintaining peace through programs such as early warning systems, meteorological, navigation and communications satellites to serve combat forces.

Space and Missile Systems Center, part of the Air Force Materiel Command, is responsible for research, development, and acquisition on-orbit testing and sustaining military space and missile systems. In addition to managing Air Force space and missile programs, SMC participates in space programs conducted by other U.S. military services, government agencies and North Atlantic Treaty Organization allies. SMC responds to user needs by developing and acquiring space systems. After launch and checkout, SMC turns these systems over to the appropriate operating command. SMC also serves as the integrating center for the Strategic Defense Initiative within AFMC. It monitors progress in more than 70 Space Defense Initiative efforts throughout AFMC. SMC itself has direct management responsibility for more than half of these efforts.

Fort MacArthur is a former Army installation acquired by the Air Force in 1982. It is named in honor of Lt. Gen. Arthur MacArthur, father of Douglas MacArthur, who later commanded American forces in the Pacific during World War II. At present, Fort MacArthur serves as a residential community for personnel of the Air Force Space Division Based at El Segundo. Fort MacArthur, the actual site for the fuel cell installation, is in San Pedro, about 13 miles south of the main base.

8.0 Fuel Cell Installation

One Plug Power 5kW GenSys 5C fuel cell was installed and operated at the LA AFB Civil Engineering Office, Building 56. Figure 1 displays the GynSys5C unit placed in the fenced yard adjacent to the Civil Engineering Headquarters. LOGAN technicians dug a trench to install the thermal recovery tubing, natural gas supply piping, and electric conduit between the unit and the building to protect the aesthetic appearance of the yard. Figures 3 through 5 show this process.

Figure 1 – Completed Installation

Figure 2 – Electrical connections and heat recovery connections at the unit.

Figure 3 – Trenching pathway to the facility

Figure 4 – Trenching detail at the fuel cell

Figure 5 – Detail of gas and thermal connections at fuel cell

Figure 6 – Photo of gas service meter at the site

In order to construct the project, a digging permit was issued by the base, and LOGAN was required to enter into a separate indemnity agreement before work could commence. This was the first such permit that LOGAN had encountered in the CERL PEM demonstration program from its inception in 2001. The project got underway in mid March 2005. The installation progressed according to plan with minimal inconvenience to the base or the host site, and the unit had its first start on May 10, 2005. However, DSL Ethernet service to the fuel cell router was not established until the end of May whereupon the unit became fully operational.

While operating at a set point of 2.5 kW, the unit consumes 35,000 SCF/H natural gas and delivers approximately 7,800 Btu/h at 140 degrees F to the customer heat exchanger. In order to achieve the program objective of 90% operational availability, LOGAN operated the unit until the end of October 2006. At the time of its decommissioning, the unit had achieved 93% availability.

The line diagram pictured in Figure 7, illustrates the electrical and mechanical interfaces between the fuel cell and the host facility.

LA AFB PEM Fuel Cell Installation
One-Line Diagram

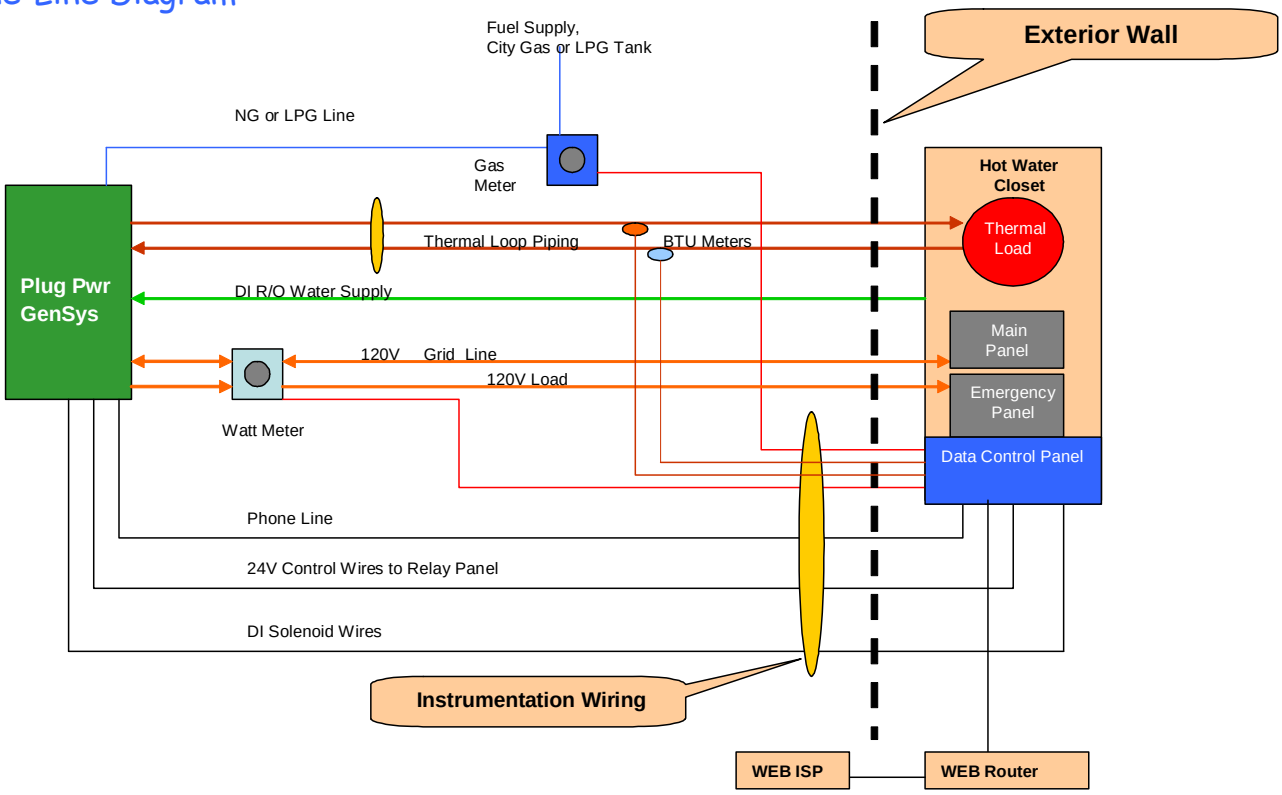


Figure 7 – Simple line diagram of the LA ARB fuel cell installation showing key utility interfaces required to operate the unit at the site.

9.0 Electrical System

The Plug Power GenSys 5C PEM fuel cell power plant provides both grid parallel and grid independent operating configurations for site power management. This capability is an important milestone in the development of the GenSys5 product and for the PEM Program itself, as it is a significant developmental step on the pathway to product commercialization. The unit has a power output of 110/120, VAC at 60. Figure 8 below, shows the electrical service panel in the basement of Building 56 where the fuel cell was electrically connected to the base utility grid. A new fuel cell emergency panel was installed adjacent to the existing panels and has several non-critical circuits attached to simulate the fuel cell's stand-by power application.

Figure 8 – Electrical panels in the host facility that distribute the fuel cell electrical power output

10.0 Thermal Recovery System

Figure 9 - Photo of hot water tank servicing the host facility.

LOGAN employed a Heliodyne heat exchanger to capture fuel cell waste heat and transfer the heat into the facility's hot water heater, pictured in Figure 9. The Heliodyne is a looped coil within a coil design that provides double wall protection between the heat source and the heat sink. It was designed primarily for the solar heating industry, but has proved to be very adaptable to the fuel cell industry as well. Figures 10 and 11 show the Heliodyne mounted on an adjacent wall with its own pump, which circulates the storage tank in a counter flow against incoming hot water provided by the fuel cell's heat exchanger. While operating at a set point of 2.5 kWh, the fuel cell provided 7800 BtuH to the storage tank at approximately 140 degrees F.

Figure 10 – Close up of the Heliodyne heat exchanger and controls that transfer fuel cell waste heat into the hot water heater pictured in Figure 9.

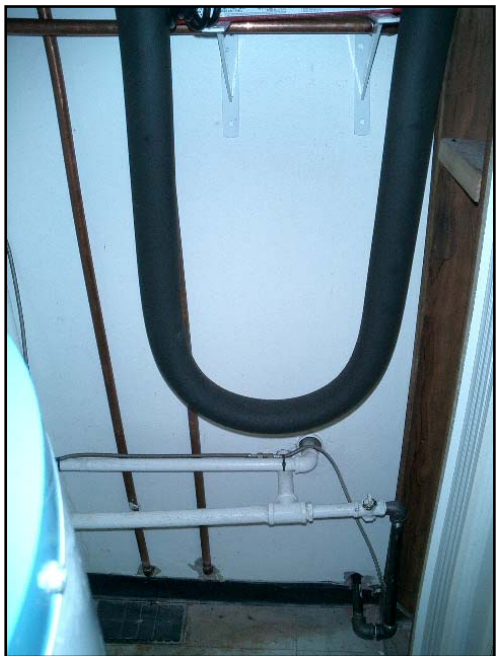


Figure 11 – Lower coil section of the Heliodyne heat exchanger showing "U" shaped loop that provides expanded surface area for heat transfer.

Please see performance charts in Appendix section 5 for additional operating details.

11.0 Communications

LOGAN installed a Connected Energy Corporation web-based SCADA system that provided real-time monitoring, data collection, and data storage of the power plant's operations. The schematic drawing, in Figure 12, describes the architecture of the CEC hardware that supported the project. The system provided a comprehensive data acquisition solution; incorporating remote control, alarming, notification, and reporting functions. It also displayed a number of fuel cell operating parameters on functional display screens including kWh, cell stack voltage, and water management, as well as external instrumentation inputs including Btus, fuel flow, and thermal loop temperatures. Figure 13 displays the Connected Energy Web Data Screen. CEC's Operations Control Center in Rochester, New York collects, stores, displays, alarms, archives site data, and maintains connectivity by means of a Virtual Private Network that linked the fuel cell to CEC's control center.

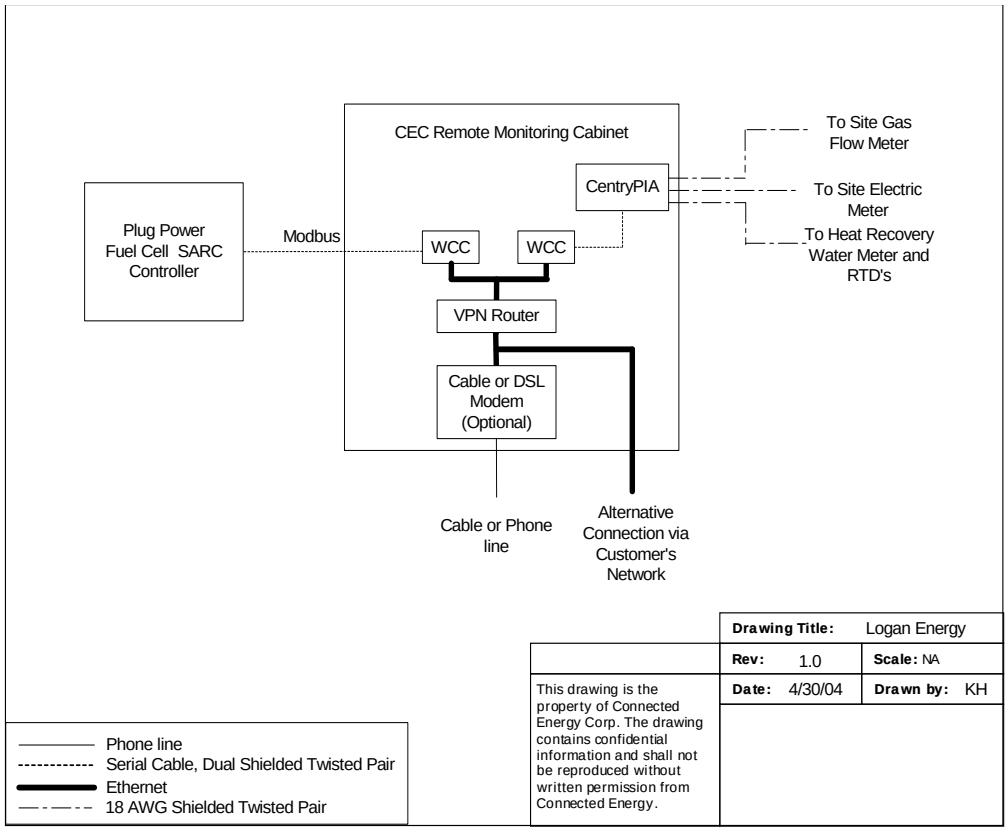
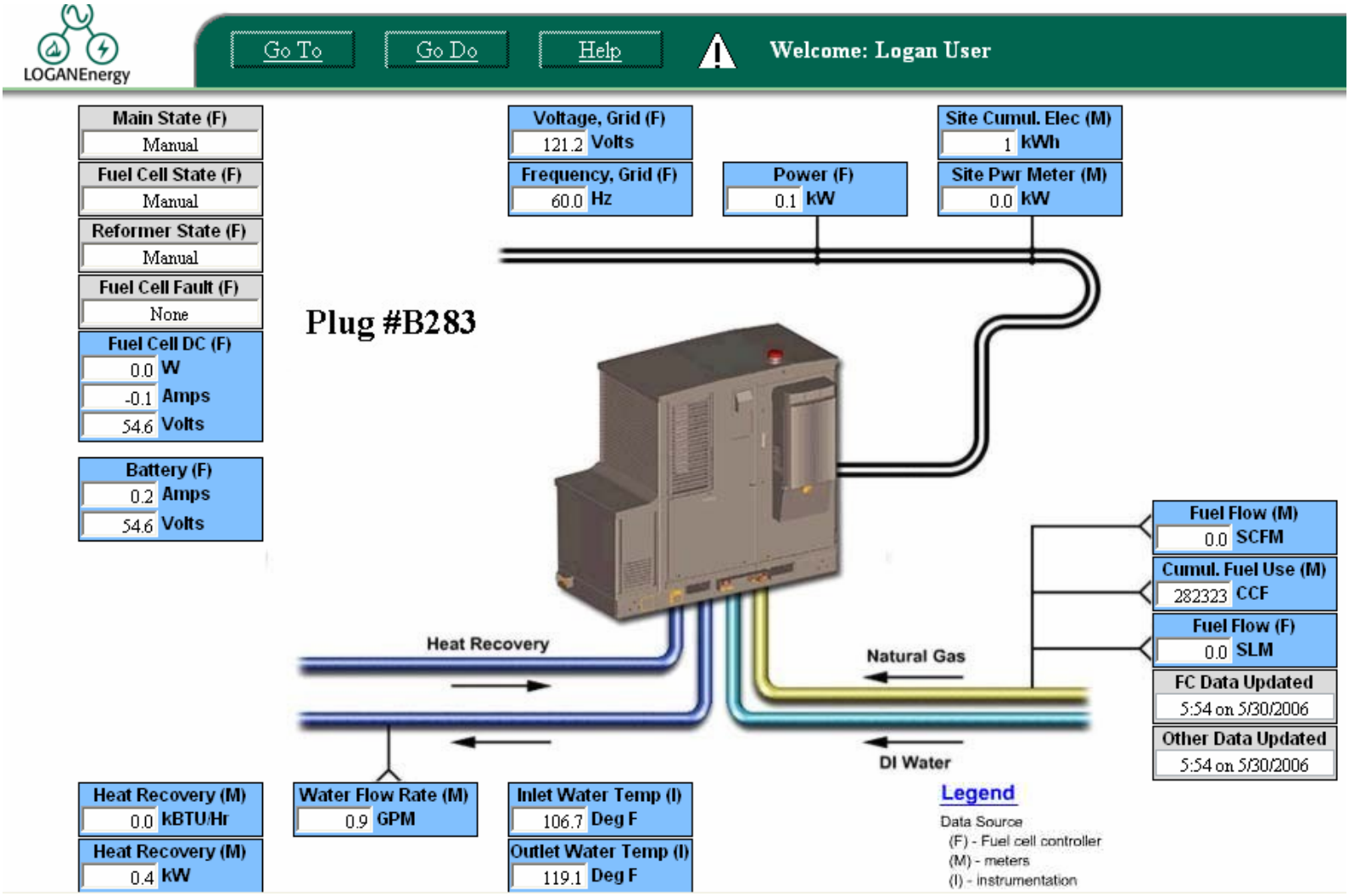


Figure 12 – CEC WEB enabled SCADA terminal hardware architecture



12 Figure 13 – Connected Energy Web Data Screen from 5:54 PM on 5/30/06 showing a number of performance data points for S/N B283, the GenSys serial number of the LA AFB unit.

Fuel Supply System

LOGAN connected the fuel cell gas piping into the existing natural gas service line pictured in Figure 6, and installed a flow meter to calculate fuel cell usage as detailed in Paragraph 8.0. A regulator at the fuel cell gas inlet maintained the correct fuel cell operating pressure at 14 inches water column. The Gensys5C consumed 33,000SCF/H of fuel while operating at a set point of 2.5kWh.

13.0 Program Costs

Las Angeles AFB, CA								
Project Utility Rates			**Utility**					
1) Water (per 1,000 gallons)	$0.85	Southern California Water Company						
2) Utility (per KWH)	$0.1100	Southern California Electric Company						
3) Natural Gas (per MCF)	$9.55	Southern California Gas Company						
First Cost				**Estimated**		**Actual**		**Variance**
Plug Power 5 kW GenSys5C				$ 65,000		$ 65,000		$ -
Shipping				$ 2,400		$ 675		$ 1,725
Installation electrical				$ 2,800		$ 1,800		$ 1,000
Installation mechanical & thermal				$ 6,300		$ 4,200		$ 2,100
Watt Meter, Instrumentation, Web Package				$ 1,285		$ 11,301		$ (10,016)
Site Prep, labor materials				$ 825		$ 367		$ 458
Technical Supervision/Start-up				$ 4,500		$ 9,039		$ (4,539)
Total				**$ 83,110**		**$ 92,382**		$ (9,272)
Assume Five Year Simple Payback				$ 16,622		$ 18,476		$ (1,854)
Forcast Operating Expenses	Volume		$/Hr	$/ Yr				
Natural Gas Mcf/ hr @ 2.5kW	0.033	$	0.32	$ 2,917.66				
Water Gallons per Year	14,813			$ 12.59				
Total Annual Operating Cost						$ 2,930.25		
Economic Summary								
Project kWH			22,485					
Annual Cost of Operating Power Plant		$	0.130	kWH				
Credit Annual Thermal Recovery			($0.008)	kWH				
Project Net Operating Cost		$	0.1228	kWH				
Displaced Utility cost		$	0.1100	kWH				
Energy Savings (Cost)			($0.013)	kWH				
Annual Energy Savings (Cost)			($287.92)					

Explanation of Calculations:

Actual First Cost Total is a *sum* of all the listed first cost components.

Assumed Five Year Simple Payback is the Estimated First Cost Total *divided by* 5 years.

Project Costs:
The Gensys5C fuel cell system set at 2.5 kW consumes 0.033 MCF per hour. The cost per hour is 0.033 Mcf per hour *x* the cost of natural gas... $11.00/MCF. The

cost per year at $3637 is the cost per hour at $0.32 *x* 12410 hours *x* 93% availability.

Natural gas fuel cell systems set at 2.5 kW will consume 1.6 gallons of water per hour through the DI panel. The total volume of water consumed at 14,813 gallons per year is 1.6 gph *x* 9,258 hours. The cost per year at $12.59 is 14,813 gph *x* cost of water to the site at $0.85 per 1000 gallons.

The Total Annual Operating Cost, $2,930 is the *sum of* the cost per year for the natural gas and the cost per year for the water consumption.

Economic Summary:
The Annual Cost of Operating the Power Plant at $0.127 per kWH is the Total Annual Operating Cost at $2,930 *divided by* project kWh at 22,485kWh.

The Credit for Annual Thermal Recovery of -$0.008 is a credit to the operating cost expressed in kWh. As a credit, the value is expressed as a negative number.

The Project Net Operating Cost is the *sum* of the Annual Cost of Operating the Power Plant *plus* the Credit Annual Thermal Recovery.

The Displaced Utility Cost is the cost of electricity to LA AFB per kWh.

Energy Savings (cost) equals the Displaced Utility Cost *minus* the Project Net Operating Cost.

Annual Energy Savings (cost) equals the Energy Savings *x* the project kWh.

14.0 Milestones/Improvements

Plug Power GenSys5C S/N 283 achieved 93% overall availability during its 17 month performance evaluation at Los Angeles Air Force Base. The unit incorporated the MP-5 inverter designed by Plug Power to provide both grid parallel/grid synchronous and grid independent/load following capabilities. This capability is an important milestone in the development of the Gensys5 product and for the PEM Program itself, as it is a significant developmental step on the pathway to product commercialization. In this particular project, that capability allowed LOGAN to install an “emergency Load” panel at the host site and transfer several circuits to that panel.

S/N 283 also included the capability to recover waste heat through the addition of a heat exchanger attached to the site’s water heater unit for that purpose. Fuel cell heat is normally rejected through an air-cooled radiator on the unit, but the introduction of a Heliodyne heat exchanger allowed LOGAN to supply fuel cell heat to satisfy the relatively minor thermal demands encountered at Bldg 56. LOGAN believes that heat recovery techniques need further refinement. A promising area includes future activities focused on integrating into fuel cell projects small commercial HVAC products that will significantly increase thermal recovery load factors. If successfully integrated into a fuel cell energy package,

these products will add value to the fuel cell installation and reduce consumer energy costs for heating and cooling.

15.0 Decommissioning/Removal/Site Restoration

S/N 283 was decommissioned and the unit removed from LA AFB during November 2006. The unit was cannibalized for good parts and the remainder was delivered to a local scrap yard.

Figure 14 – LA AFB restored to original condition following decommissioning.

Following the removal of the unit, LOGAN also removed the emergency electrical panel, deconstructed the thermal recovery system leaving the hot water tank in its original configuration.
At the completion of the process, LOGAN's work was inspected by the project POC and the project was concluded.
The photo at left shows the site restored to original condition.

16.0 Additional Research/Analysis

LOGAN performed a series of harmonics tests on the unit under normal operations using an Amprobe Harmon Link 2 testing device; the results of this testing are presented in Appendix Section 4. The data describes two test conditions: the inverter harmonics in a grid connected configuration at 2.5kW, and the stand alone grid harmonics.

The IEEE Standard, 519-1992, that governs the performance of the Plug Power states that

1. Total Voltage Harmonic Distortion at rated inverter output is limited to 5% of fundamental frequency voltage, and
2. Individual Frequency Harmonics Distortion is limited to 3% of fundamental frequency voltage.

Referring to the Charts in Appendix 4, the test results indicate that at the time the measurements were taken, no individual Frequency Harmonic exceeded the IEEE standard of 3%, and that total Voltage Harmonic Distortion at 1.6% was well below the upper IEEE limit of 5%.

17.0 Conclusions/Summary

In general terms, the LA Air Force Base project did not encounter any major obstacles or other events that patience and cooperation among the stakeholders did not eventually solve. The project was ably supported by the Air Force and in particular Mr. Eddie Wilson, the base energy manager, was very cooperative and supportive. One significant difference that LOGAN encountered at LA AFB that proved to be a first was the requirement that LOGAN enter into a separate agreement with LA AFB over the conduct of the project. After consultations with CERL, LOGAN accepted the agreement and complied with all of its terms. A copy of the agreement is attached to the Appendix section of this report.

Unlike many previous sites, LA AFB assisted with expeditious processing of the requirements to allow LOGAN to bring high speed DSL service to the fuel cell. The unit was commissioned on May 15, 2005 and by the end of the month the DSL service was on-line providing remote connectivity with the site.
This site was allowed to extend its operating period by approximately 5 months because funding was shifted from a site devastated by hurricane Katrina. With the exception of the first two months of the extended period, the unit ran with 100% availability.

In summary, the lesson learned at this site will have positive implications for future PEM operations and customer services. As these experiences are transferred to future installations they will directly benefit the community of CERL projects and equally enhance the reliability of future Plug Power products. This project elevated the awareness of fuel cell technology at LA Air Force Base, educated the California hydrogen and fuel cell community and advanced the broader objectives of the fuel cell industry toward the ultimate goal of product commercialization.

Appendix

1) **Monthly Performance Data**

LA AFB Monthly Performance Chart

System Number:	**SU01B000000283**		**Commission Date:**	**5/10/2005**	
Site Name:	**Los Angeles AFB**		**Fuel Cell Type:**	**Plug Power PEM**	
Fuel Type:	**Natural Gas**		**Maintenance Contractor:**	**LOGANEnergy Inc.**	
Lower Heating Value:	**943**	**BTU/scf**	**Local Residential Fuel Cost per Therm:**		**$/Therm**
Capacity kW	**5**		**Local Residential Electricity Cost per kWhr:**		**$/kWhr**

Month	Run Time (Hours)	Time in Period (Hours)	Availability (%)	Energy Produced (kWe-hrs AC)	Output Setting (kW)	Average Output (kW)	Capacity Factor (%)	Fuel Usage, LHV (kWh)	Fuel Usage, LHV (BTUs)
insert month	*insert operating hours*	*insert hours in month*	**1*	*insert produced energy*	*insert output setting*	**2*	**3*	*insert fuel consumption*	
May, 2005	575	575	100%	1553.0	2.5	2.70	54.02%	6847	2.34E+07
June, 2005	720	720	100%	1795.4	2.5	2.49	49.87%	6693	2.28E+07
July, 2005	744	744	100%	1860.0	2.5	2.50	50.00%	7132	2.43E+07
August, 2005	744	744	100%	1862.0	2.5	2.50	50.05%	7326	2.50E+07
September, 2005	357	720	50%	851.0	2.5	2.38	23.64%	3479	1.19E+07
October, 2005	744	744	100%	1361.0	2.5	1.83	36.59%	6217	2.12E+07
November, 2005	720	720	100%	1656.0	2.5	2.30	46.00%	6718	2.29E+07
December, 2005	744	744	100%	1862.0	2.5	2.50	50.05%	7293	2.49E+07
January, 2006	744	744	100%	1620.0	2.5	2.18	43.55%	7300	2.49E+07
February, 2006	528	672	79%	1320.0	2.5	2.50	39.29%	5980	2.04E+07
March, 2006	628	744	84%	1574.6	2.5	2.51	42.33%	6142	2.10E+07
April, 2006	720	720	100%	1867.5	2.5	2.59	51.88%	7300	2.49E+07
May, 2006	57	744	8%	220.9	2.5	3.88	5.94%	552	1.88E+06
June, 2006	489	720	68%	1222.5	2.5	2.50	33.96%	5538	1.89E+07
July, 2006	744	744	100%	1860	2.5	2.50	50.00%	7288	2.49E+07
August, 2006	744	744	100%	1860	2.5	2.50	50.00%	7291	2.49E+07
Septmeber, 2006	720	720	100%	1800	2.5	2.50	50.00%	7056	2.41E+07

Site Location(City,State): El Segundo, California

Local Base Fuel Cost per Therm: 0.955 $/Therm
Local Base Electricity Cost per kWhr: 0.11 $/kWhr

Fuel Usage (SCF)	Electrical Efficiency (%)	Thermal Heat Recovery (BTUs)	Heat Recovery Rate (BTUs/hour)	Thermal Efficiency (%)	Overall Efficiency (%)	Number of Scheduled Outages	Scheduled Outage Hours	Number of Unscheduled Outages	Unscheduled Outage Hours
	*4	*insert heat recovery*	*5	*6	*7	*insert value*	*insert value*	*insert value*	*insert value*
23096	22.69%	0	0	0.00%	22.69%	0	0	0	0
22576	26.84%	0	0	0.00%	26.84%	0	0	0	0
24057	26.09%	0	0	0.00%	26.09%	0	0	0	0
24711	25.43%	1790700	2406.854839	7.16%	32.60%	0	0	0	0
11735	24.48%	2103200	5891.316527	17.72%	42.19%	0	0	2	363
20971	21.90%	2868600	3855.645161	13.52%	35.43%	0	0	0	0
22661	24.66%	2774300	3853.194444	12.10%	36.77%	0	0	0	0
24600	25.55%	1635600	2198.387097	6.57%	32.12%	0	0	0	0
24624	22.20%	1592300	2140.188172	6.39%	28.60%	0	0	0	0
20171	22.09%	2012400	3811.363636	9.86%	31.95%	0	0	1	144
20718	25.65%	1133000	1804.140127	5.41%	31.06%	0	0	1	116
24624	25.60%	620800	862.2222222	2.49%	28.09%	0	0	0	0
1862	40.04%	23250	407.8947368	1.23%	41.28%	0	0	1	687
18680	22.09%		0	0.00%	22.09%	0	0	1	231
24583	25.54%		0	0.00%	25.54%	0	0	0	0
24593	25.53%			0.00%	25.53%	0	0	0	0
23801	25.53%					0	0	0	0

Fuel Cell Site Grand Totals	
Run Time (Hours)	9258
Time in Period (Hours)	10799
Availability (%)	85.73%
Energy Produced (kWe-hrs AC)	22485.9
Output Setting (kW)	2.50
Average Output (kW)	2.43
Capacity Factor (%)	41.64%
Fuel Usage, HHV (BTUs)	3.13E+08
Fuel Usage (SCF)	309668
Electrical Efficiency (%)	24.51%
Thermal Heat Recovery (BTUs)	16554150
Heat Recovery Rate (BTUs/hour)	1788.09
Thermal Efficiency (%)	5.28%
Overall Efficiency (%)	29.79%
Number of Scheduled Outages	0
Scheduled Outage Hours	0
Number of Unscheduled Outages	6
Unscheduled Outage Hours	1541

2) Daily Work Logs

LOGANEnergy Field Technicians

September '04 – November'06

LOGANEnergy Corp.					
Monthly Site Report					
Period	June-04				
Site	LA AFB				
Engineer	**Date**	**PP S/N**	**Activity**	**Mileage**	**Hours**
Collard & Altemoos	6/2/2004	283	Visited Ft. McArthur and met with Ed Wilson. Looked at several possible sites for the Fuel Cell hosted by Los Angeles AFB.	157	12

LOGANEnergy Corp.					
Monthly Site Report					
Period	May-05				
Site	LA AFB				
Engineer	**Date**	**PP S/N**	**Activity**	**Mileage**	**Hours**
Collard	5/5/2005	283	Continue FC installation.	10	16

LOGANEnergy Corp.					
Monthly Site Report					
Period	October-05				
Site	LA AFB				
Engineer	**Date**	**PP S/N**	**Activity**	**Mileage**	**Hours**
Altemoos	10/26/2005	283			
			Methane sensor replaced, machine running.	2	3
			Machine started	200	5
			Trouble shot machine, conducted pm and changed filters loaded new modem software, started machine running no problems.	160	3

Report Date:	9/19/2005	**Technician Initials:**	mpa	**FC Serial #:**	B283

Event: shutdown
Total Hours On-Site: 8
Mileage: 340rt

Type of Outage:
- ☐ Scheduled
- ☑ Unscheduled

Failure Date/Time: 9/11/05 0:00
Restart Date/Time: 9/19/05 0:00
Total Hours Unavailable: 192

Meter Readings:
Gas
Electric
BTU
FC Operating Hours

Problem Description: **9/11/2005 11:03:55 PM,Running (51)ESTOP, HW_ESTOP_FG3_L6, Error Code: (532)(0)**

Service Performed or Corrective Action Taken: Changed filters and loaded new modem software machine running

Report Date:	9/29/2005	**Technician Initials:**	mpa	**FC Serial #:**	B283

Event: system was running w/out grid do to storm, GLSB and shutdown 9-20-05 due to ESTOP,HW_FG3_L6,ERROR CODE 5
Total Hours On-Site: 8
Mileage: 340RT

Type of Outage:
- ☐ Scheduled
- ☑ Unscheduled

Failure Date/Time: 9/20/05 0:00
Restart Date/Time: 9/29/05 0:00
Total Hours Unavailable: 216

Meter Readings:
Gas
Electric
BTU
FC Operating Hours

Problem Description: **HW_ESTOP_FG3_L6, Error Code: (532)(0)**

Service Performed or Corrective Action Taken: unable to find any leaks changed out methane sensor and restarted machine

LOGANEnergy Corp.					
Monthly Site Report					
Period	August-05				
Site	LA AFB				
Engineer	**Date**	**PP S/N**	**Activity**	**Mileage**	**Hours**
Altemoos	8/15/2005	283	Tech showed up on site and could not fix problem, have to get with base tell and push signal to site, have trouble ticket ref#100720647 tech sp87x621	200	8

LOGANEnergy Corp.								
Work Log Site Report								
Report Date	10/26/2005							
Site								
Power Plant Serial Number	B283							
Engineer	Michael Altemoos							
Hours	3.00							
Mileage	160							
Event	maintenace call							

Incident Report							
Type of Outage	Unscheduled			Scheduled or Unscheduled			
Failure Date	9/11/2005						
Shutdown Time	11:00 am						
Restart Date	9/19/2005						
Restart Time	12:30 pm						
Hours Unavailable	194.50	8 Days, 2 Hours, 30 Minutes.					
Gas Meter Reading	0.00						
Electric Meter Reading	0.00						
BTU Meter Reading	0.00						
Fuel Cell Reading	0.00						
Describe Problem	Shut down FG3-L6						
Service/Corrective Action	Trouble shot machine,conducted pm and changed filters loaded new modem software, started machine running no problems.						

LOGANEnergy Corp.								
Work Log Site Report								
Report Date	10/26/2005							
Site								
Power Plant Serial Number	B283 -1							
Engineer	Michael Altemoos							
Hours	5.00							
Mileage	200							
Event	maintenace call							

Incident Report							
Type of Outage	Unscheduled			Scheduled or Unscheduled			
Failure Date	9/20/2005						
Shutdown Time	12:47 pm						
Restart Date	9/21/2005						
Restart Time	3:28 pm						
Hours Unavailable	27.68	1 Day, 3 Hours, 41 Minutes.					
Gas Meter Reading	0.00						
Electric Meter Reading	0.00						
BTU Meter Reading	0.00						
Fuel Cell Reading	0.00						
Describe Problem	machine shut down for FG-3-L-6 machine spent the last days in GLSB and did not make the transition back to the grid, machine started, identified bad methane sensor.						
Service/Corrective Action	machine started,						

Report Date:	10/26/2005	**Technician Initials:**	mpa	**FC Serial #:**	B283

Event: shutdown
Total Hours On-Site:
Mileage: 340rt

Type of Outage:
- ☐ Scheduled
- ☑ Unscheduled

Meter Readings:

Gas	
Electric	
BTU	
FC Operating Hours	

Failure Date/Time: 10/25/05 0:00
Restart Date/Time: 10/26/05 0:00
Total Hours Unavailable: 24

Problem Description: **shutdown FG-3 L6**

Service Performed or Corrective Action Taken: CHANGED FILTERS CONDUCTED PREVENTIVE MAINTENANCE AND RESTARTED

Report Date:	10/28/2005	**Technician Initials:**	MPA	**FC Serial #:**	B283

Event: system in GLSB
Total Hours On-Site: 2
Mileage: 340rt

Type of Outage:
- ☐ Scheduled
- ☑ Unscheduled

Meter Readings:

Gas	
Electric	
BTU	
FC Operating Hours	

Failure Date/Time:
Restart Date/Time:
Total Hours Unavailable: 0

Problem Description: **system in grid loss standby since 10-25-05**

Service Performed or Corrective Action Taken: , moved switch back to normal and machine is exporting power @2.5kw

Report Date:	3/16/2006	**Technician Initials:**	mpa	**FC Serial #:**	B283

Event: Shutdown LEVS5_HUMID_LOW_SD
Total Hours On-Site: 6
Mileage: 340rt
Type of Outage: ☐ Scheduled ☑ Unscheduled

Failure Date/Time: 3/1/06 0:00
Restart Date/Time: 3/16/06 0:00
Total Hours Unavailable: 360

Meter Readings:	
Gas	
Electric	
BTU	
FC Operating Hours	

Problem Description: **SYSTEM NOT GETTING ENOUGH WATER,**

Service Performed or Corrective Action Taken: trouble shot water system, replaced filter and adjusted flow rate, restarted machine running

Report Date:	5/9/2006	**Technician Initials:**	mpa	**FC Serial #:**	B283

Event: loss ATO blower code 546
Total Hours On-Site: 14
Mileage: 340rt
Type of Outage: ☐ Scheduled ☑ Unscheduled

Failure Date/Time: 5/3/06 0:00
Restart Date/Time: 7/12/06 0:00
Total Hours Unavailable: 1680

Meter Readings:	
Gas	
Electric	
BTU	
FC Operating Hours	

Problem Description: **loss ATO blower shutdown**

Service Performed or Corrective Action Taken: troubleshot system and found that the ato blower is fine, filter alittle dirty, restarted machine, during start up press 5 failed. Replaced press5 and restarted, during start up I identified rotted drain lines out of the prox .site hour for april were 100% 100% and directed to leave machine in idle do to it's end of contract comming up. 5/31/06 we decided to scrap Sierra and take the prox from that system and fix L.A. double click on pd sign

Report Date:	6/20/2006	**Technician Initials:**	mpa	**FC Serial #:**	B283

Event: change out prox per last report
Total Hours On-Site: 6
Mileage: 340rt
Type of Outage: ☐ Scheduled ☑ Unscheduled
Failure Date/Time:
Restart Date/Time:
Total Hours Unavailable: 0

Meter Readings:
Gas
Electric
BTU
FC Operating Hours

Problem Description: **machine still in stand by waiting for prox assembly**

Service Performed or Corrective Action Taken: changed out prox started machine, having problems with press5 waiting for tech support

Report Date:	6/30/2006	**Technician Initials:**	mpa	**FC Serial #:**	B283

Event: ordered press 4 and two flappers
Total Hours On-Site: 4
Mileage: 340rt
Type of Outage: ☐ Scheduled ☑ Unscheduled
Failure Date/Time:
Restart Date/Time:
Total Hours Unavailable: 0

Meter Readings:
Gas
Electric
BTU
FC Operating Hours

Problem Description: **system won't start press4 and flappers need to be replaced**

Service Performed or Corrective Action Taken: parts on order

Report Date:	7/12/2006	**Technician Initials:**	kw	**FC Serial #:**	B283

Event: replace press4 and flappers
Total Hours On-Site: 8
Mileage: 160rt
Type of Outage: ☐ Scheduled ☑ Unscheduled
Failure Date/Time:
Restart Date/Time:
Total Hours Unavailable: 0

Meter Readings:

Gas	
Electric	
BTU	
FC Operating Hours	

Problem Description: **change out parts**

Service Performed or Corrective Action Taken: parts changed out machine started no problems, phone line not working

Report Date:	9/15/2006	**Technician Initials:**	mpa	**FC Serial #:**	B283

Event: check on phone line
Total Hours On-Site: 5
Mileage: 340rt
Type of Outage: ☐ Scheduled ☑ Unscheduled
Failure Date/Time:
Restart Date/Time:
Total Hours Unavailable: 0

Meter Readings:

Gas	
Electric	
BTU	
FC Operating Hours	

Problem Description: **phone line not working**

Service Performed or Corrective Action Taken: identified that when the base changed over prefixes that the dropped the line at the base

LOGANEnergy
The power of fuel cells.

Incident Report/Work Log

LA AFB

Report Date:	11/7/2006	**Technician Initials:**	mpa	**FC Serial #:**	B283
Event:	Decommission Unit				
Total Hours On-Site:	48				
Mileage:	190				
Type of Outage:	☑ Scheduled ☐ Unscheduled				
Failure Date/Time:					
Restart Date/Time:					
Total Hours Unavailable:	0				

Meter Readings:

Gas	
Electric	
BTU	
FC Operating Hours	

Problem Description: **End of demonstration**

Service Performed or Corrective Action Taken: removed FC and all heat recovery and associated hardware

3) Copy of Agreement with LA AFB

MEMORANDUM FOR: LOGAN ENERGY 4 June 04
CERL, CORPS OF ENGINEERS
6767 ADOBE ROAD.
TWENTYNINE PALMS, CA 92277

FROM: 61 CONS/LGCC
2420 VELA WAY, SUITE. 1467
EL SEGUNDO CA 90245-4659

SUBJECT: PRODUCT DEMONSTRATION AGREEMENT NO. 0000-61 CONS- 0001,
DELIVERY OF 1 FUEL CELL

1. The U.S. Air Force hereby accepts the attached offer of LOGAN Energy, for one fuel cell generator, dated 30 June 2004, to deliver 1 each fuel cell as a product demonstration agreement project at a cost to the Air Force. Delivery shall be to 61 Air Base Group Civil Engineering, Bldg 56, Los Angeles Air Force Base, San Pedro, CA 90731. Logan Energy shall be responsible for the installation, maintenance and removal of this fuel cell and all associated components for the term of this agreement.

2. Delivery shall be coordinated with Mr. Edward Wilson, (310) 363-0904, prior to actual delivery being made. Product installation shall be completed within forty-five (45) calendar days after the approval of this product demonstration agreement by the Contracting Officer. Term for product demonstration shall be for a minimum of one year, but shall not exceed two years unless approved by the Contracting Officer. The U.S. Air Force reserves the right to terminate the product demonstration at any time during this agreement period at the convenience of the government.

3. In accordance with FAR 28.306(b) LOGAN Energy Shall be required to maintain insurance while performing work on a Government installation. LOGAN Energy Shall be required to submit proof of insurance to the Contracting Officer prior to work commencing. The following minimum amounts shall be required; (1) General Liability Insurance: Bodily injury liability insurance, in the minimum limits of $500,000.00 per occurrence; and (2) Automobile Liability Insurance: at least the minimum limits of $200,000.00 per person and $500,000.00 per occurrence for bodily injury and $20,000.00 per occurrence for property damage. Deliver proof of insurance to: 61 CONS/LGCC, 2420 Vela Way, Suite 1467, El Segundo, CA 90245-4659.

4. Approval of this product demonstration agreement shall not bind the Government to any future follow-on contracts with LOGAN Energy. LOGAN Energy agrees to return the facility to its original condition should the Government request removal of the fuel cell generator at no cost to the Government.

5 Questions may be addressed to the undersigned at (310) 363-5114.

DENNIS A. HASS
Contracting Officer

ACKNOWLEDGMENT BY LOGAN Energy:

I hereby certify that I understand and agree that the work required under this product demonstration agreement shall be at no cost to the U.S. Air Force.

NAME/TITLE: Samuel Logan, Jr.

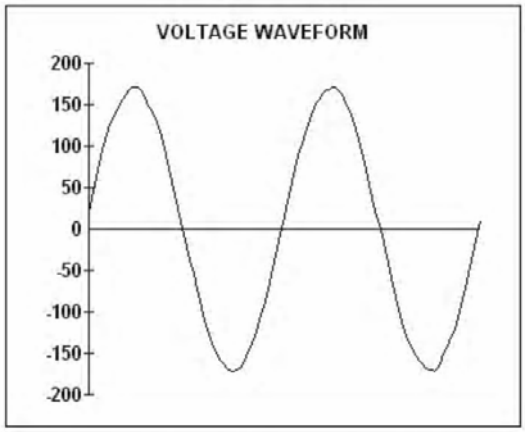
SIGNATURE: _____

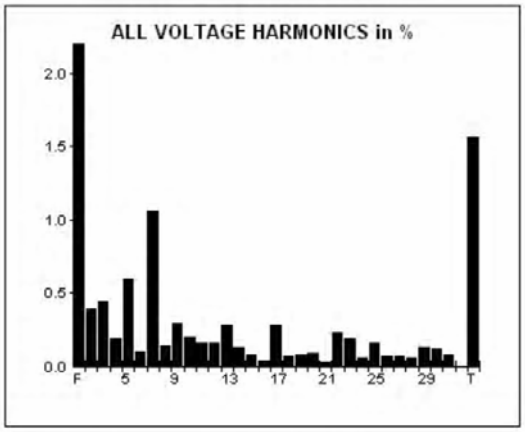
DATE: _____

4) Site Harmonics Evaluation Comparing Fuel Cell to Grid

B283 Running 2.5 kW Set Point Normal Configuration

Amprobe HarmonaLink II VOLTAGE Waveform Analysis





VOLTAGE ODD HARMONICS

H	%	RMS	Angle
1	100.0	120.50	+0
3	0.4	0.53	+139
5	0.6	0.72	-99
7	1.1	1.28	-145
9	0.3	0.35	-70
11	0.2	0.19	+146
13	0.3	0.33	-144
15	0	0	
17	0.3	0.33	-138
19	0	0	
21	0	0	
23	0.2	0.22	+8
25	0.2	0.19	+19
27	0	0	
29	0.1	0.15	+2
31	0	0	
TripIn	0.6	0.71	
Odd	1.4	1.72	
THD	1.6	1.88	

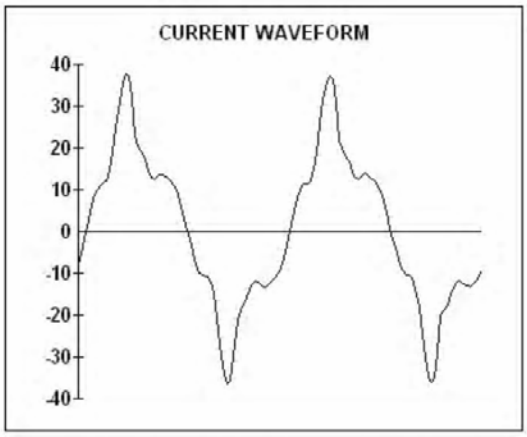
VOLTAGE EVEN HARMONICS

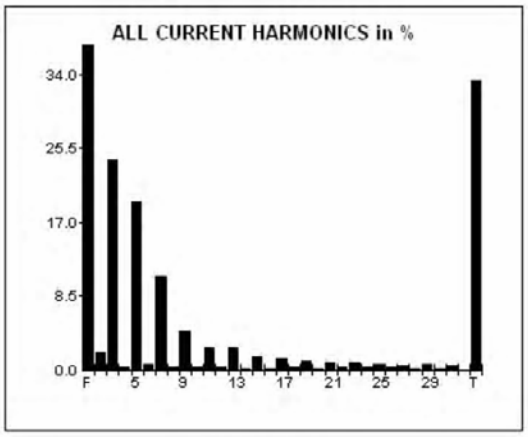
H	%	RMS	Angle
2	0.4	0.47	+154
4	0.2	0.23	+149
6	0.1	0.12	-96
8	0.1	0.17	+175
10	0.2	0.23	+163
12	0.2	0.19	-119
14	0.1	0.15	-89
16	0	0	
18	0	0	
20	0	0	
22	0.2	0.28	-77
24	0	0	
26	0	0	
28	0	0	
30	0.1	0.14	+168
Even	0.6	0.75	

VOLTAGE TOTALS

Total	120.52 rms
Peak	171.13
Average	108.16
DC Comp	0.20
Crest Factor	1.42
Form Factor	1.11
Fund Freq	60.02 Hz
Fundamental	120.50 rms
Harmonics	1.88 rms
THD Percent	1.6%
K Fctr	1.02

Amprobe HarmonaLink II CURRENT Waveform Analysis





CURRENT ODD HARMONICS

H	%	RMS	Angle
1	100.0	17.18	+0
3	24.1	4.14	-129
5	19.3	3.31	+20
7	10.7	1.83	-120
9	4.4	0.76	+91
11	2.5	0.44	-120
13	2.5	0.43	+4
15	1.4	0.25	+169
17	1.3	0.22	-26
19	0.9	0.15	+160
21	0.9	0.15	-69
23	0.7	0.13	+123
25	0.5	0.09	-94
27	0.5	0.08	+55
29	0.6	0.10	-141
31	0.5	0.08	+52
TripIn	24.6	4.22	
Odd	33.3	5.71	
THD	33.3	5.73	

CURRENT EVEN HARMONICS

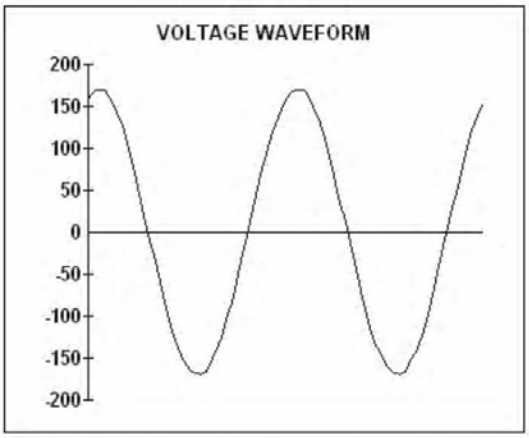
H	%	RMS	Angle
2	1.9	0.33	-85
4	0.4	0.06	-141
6	0.7	0.12	-166
8	0.2	0.03	+68
10	0.2	0.04	-119
12	0.2	0.04	-145
14	0	0	
16	0.1	0.02	-26
18	0.4	0.06	+157
20	0	0	
22	0.2	0.04	-116
24	0.3	0.05	-114
26	0.2	0.03	-171
28	0.2	0.03	-133
30	0	0	
Even	2.2	0.38	

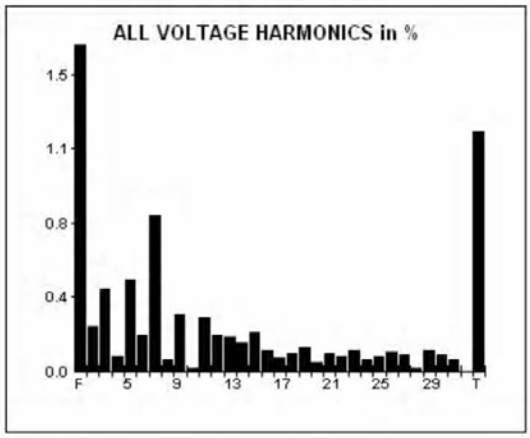
CURRENT TOTALS

Total	18.11 rms
Peak	37.35
Average	15.50
DC Comp	0.41
Crest Factor	2.06
Form Factor	1.17
Fund Freq	60.02 Hz
Fundamental	17.18 rms
Harmonics	5.73 rms
THD Percent	33.3%
K Fctr	3.28

B283 Running 2.5kW Set Point Normal Configuration

Amprobe HarmonaLink II VOLTAGE Waveform Analysis





VOLTAGE ODD HARMONICS

H	%	RMS	Angle
1	100.0	119.93	+0
3	0.4	0.50	-125
5	0.5	0.55	+155
7	0.8	0.94	-132
9	0.3	0.34	+80
11	0.3	0.32	+21
13	0.2	0.21	-48
15	0.2	0.23	-161
17	0	0	
19	0.1	0.14	+149
21	0	0	
23	0.1	0.12	-102
25	0	0	
27	0	0	
29	0.1	0.13	+99
31	0	0	
TripIn	0.6	0.75	
Odd	1.1	1.36	
THD	1.2	1.46	

VOLTAGE EVEN HARMONICS

H	%	RMS	Angle
2	0.2	0.27	+173
4	0	0	
6	0.2	0.22	-137
8	0	0	
10	0	0	
12	0.2	0.22	+4
14	0.1	0.17	-169
16	0.1	0.13	+123
18	0	0	
20	0	0	
22	0	0	
24	0	0	
26	0	0	
28	0	0	
30	0	0	
Even	0.4	0.52	

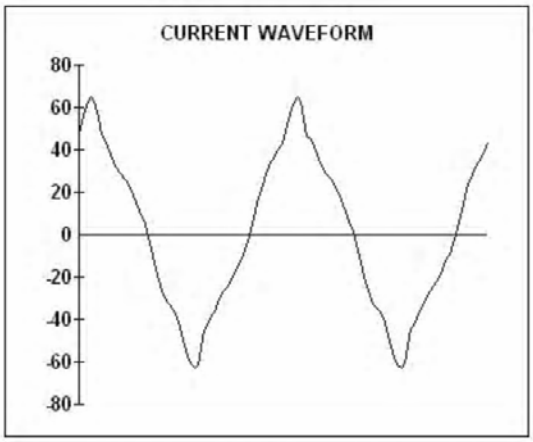
VOLTAGE TOTALS

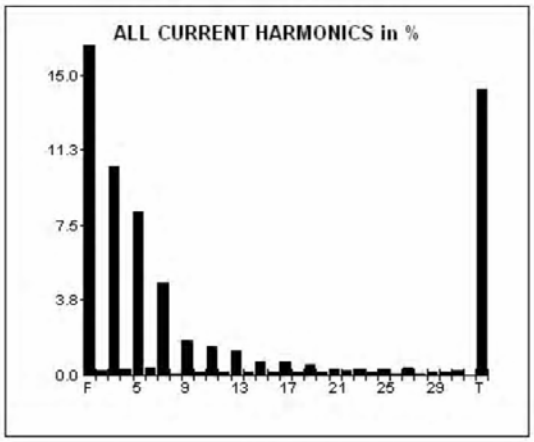
Total	119.94 rms
Peak	169.73
Average	107.76
DC Comp	0.77
Crest Factor	1.42
Form Factor	1.11
Fund Freq	60.02 Hz
Fundamental	119.93 rms
Harmonics	1.46 rms
THD Percent	1.2%
K Fctr	1.01

B283 Grid

B283 Grid

Amprobe HarmonaLink II CURRENT Waveform Analysis





CURRENT ODD HARMONICS

H	%	RMS	Angle
1	100.0	36.50	+0
3	10.4	3.79	-7
5	8.2	2.98	-100
7	4.6	1.67	-117
9	1.7	0.63	-143
11	1.4	0.53	+132
13	1.2	0.44	+43
15	0.7	0.25	-30
17	0.6	0.22	-92
19	0.5	0.18	-162
21	0.3	0.11	+115
23	0.3	0.11	+64
25	0.3	0.10	-31
27	0.3	0.11	-129
29	0.2	0.06	+176
31	0.2	0.07	+81
TripIn	10.6	3.86	
Odd	14.3	5.21	
THD	14.3	5.22	

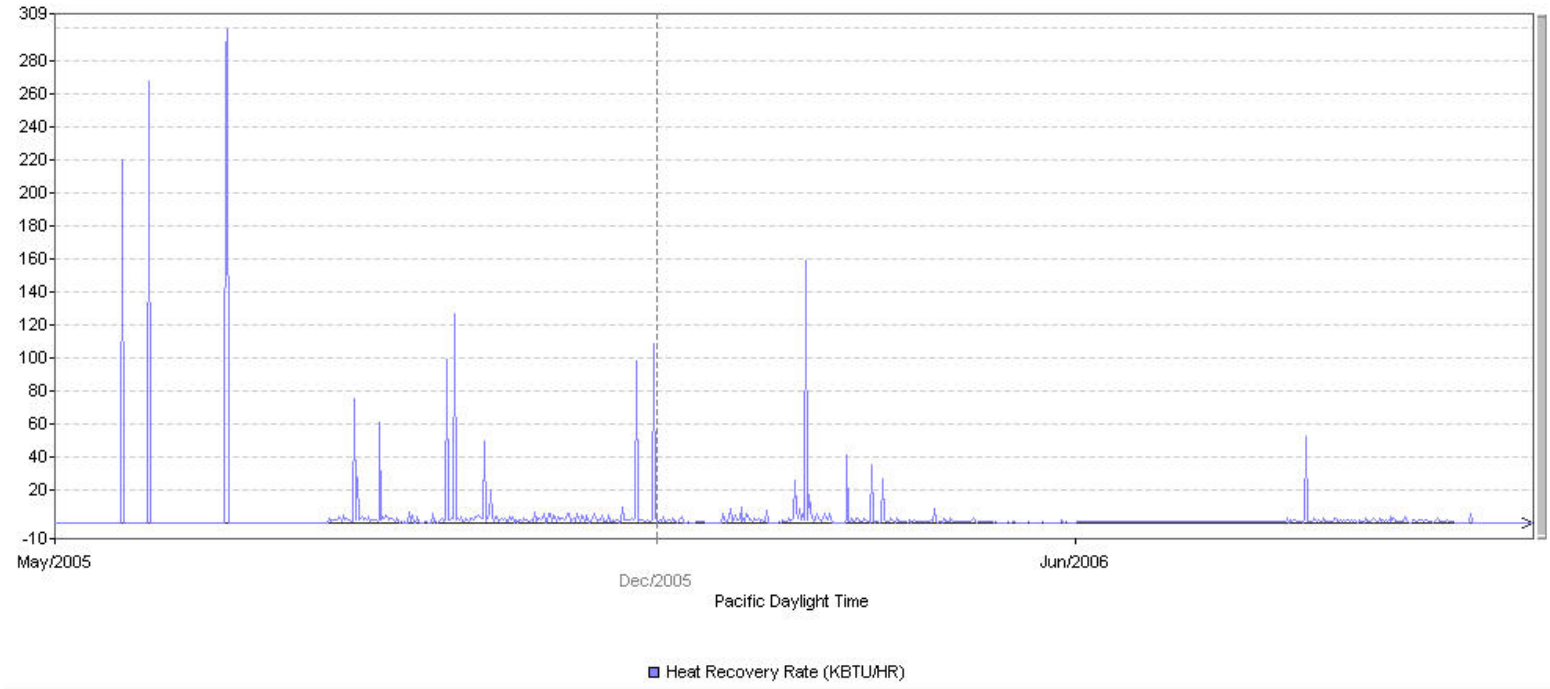
CURRENT EVEN HARMONICS

H	%	RMS	Angle
2	0.2	0.07	-144
4	0.3	0.10	+131
6	0.3	0.12	+142
8	0	0	
10	0.1	0.05	+137
12	0.1	0.04	-155
14	0.1	0.05	-166
16	0.1	0.04	-174
18	0.1	0.04	-159
20	0.1	0.04	+157
22	0.2	0.06	-144
24	0	0	
26	0	0	
28	0	0	
30	0	0	
Even	0.6	0.22	

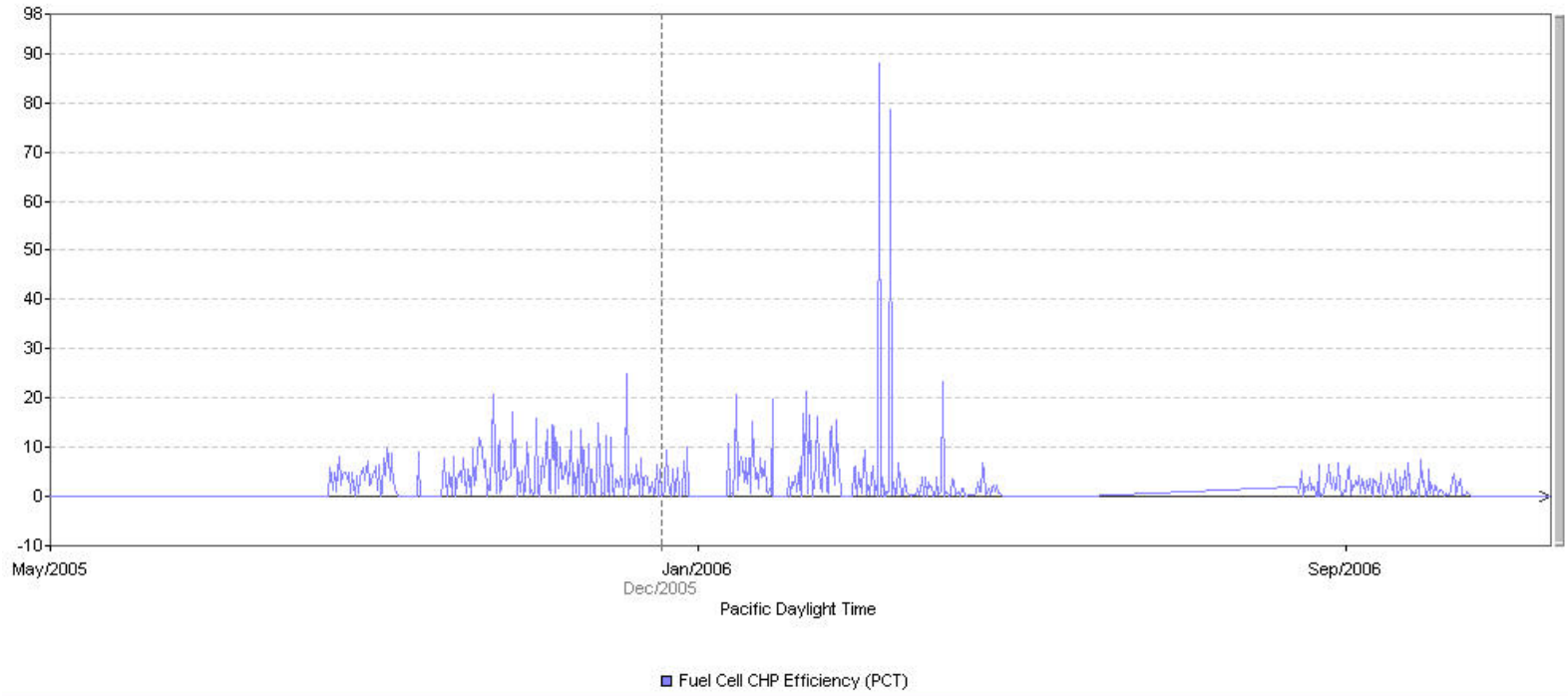
CURRENT TOTALS

Total	36.87 rms
Peak	63.83
Average	32.47
DC Comp	0.97
Crest Factor	1.73
Form Factor	1.14
Fund Freq	60.02 Hz
Fundamental	36.50 rms
Harmonics	5.22 rms
THD Percent	14.3%
K Fctr	1.47

5) Performance Charts



LA AFB graph of thermal recovery captured during the project.



LA AFB graph of fuel cell thermal efficiency captured during the project